P ENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 14 November 2000 (14.11.00)	
International application No. PCT/FI00/00274	**Applicant's or agent's file reference** OP100014/JUM
International filing date (day/month/year) 30 March 2000 (30.03.00)	**Priority date** (day/month/year) 31 March 1999 (31.03.99)
Applicant SALMELA, Olli	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

12 October 2000 (12.10.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Nestor Santesso
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PCT REQUEST

49615

Original (for **SUBMISSION**) - printed on 30.03.2000 09:34:48 AM

0	**For receiving Office use only**	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	**Form - PCT/RO/101 PCT Request**	
0-4-1	Prepared using	PCT-EASY Version 2.90 (updated 08.03.2000)
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	National Board of Patents and Registration (Finland) (RO/FI)
0-7	**Applicant's or agent's file reference**	49615
I	**Title of invention**	INVERTED MICROSTRIP TRANSMISSION LINE INTEGRATED IN A MULTILAYER STRUCTURE
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	NOKIA NETWORKS OY
II-5	Address:	P.O. Box 300 FIN-00045 Nokia Group Finland
II-6	State of nationality	FI
II-7	State of residence	FI
II-8	Telephone No.	+358-9-51121
II-9	Facsimile No.	+358-9-51168080
III-1	**Applicant and/or inventor**	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	SALMELA, Olli
III-1-5	Address:	Pajalahdentie 9 B 35 FIN-00200 Helsinki Finland
III-1-6	State of nationality	FI
III-1-7	State of residence	FI

PCT REQUEST

Original (for **SUBMISSION**) - printed on 30.03.2000 09:34:48 AM

IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	BERGGREN OY AB
IV-1-2	Address:	P.O. Box 16 FIN-00101 Helsinki Finland
IV-1-3	Telephone No.	+358-9-693701
IV-1-4	Facsimile No.	+358-9-6933944
IV-1-5	e-mail	email.box@berggren.fi
V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW

49615

PCT REQUEST

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V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3. the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	**Exclusion(s) from precautionary designations**	NONE	
VI-1	**Priority claim of earlier national application**		
VI-1-1	Filing date	31 March 1999 (31.03.1999)	
VI-1-2	Number	990717	
VI-1-3	Country	FI	
VI-2	**Priority document request** The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	**International Searching Authority Chosen**	Swedish Patent Office (ISA/SE)	
VIII	**Check list**	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	7	-
VIII-3	Claims	1	-
VIII-4	Abstract	1	49615.txt
VIII-5	Drawings	3	-
VIII-7	TOTAL	16	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	**Figure of the drawings which should accompany the abstract**	2	
VIII-19	**Language of filing of the international application**	Finnish	
IX-1	**Signature of applicant or agent**		
IX-1-1	Name	BERGGREN OY AB	
IX-1-2	Name of signatory	Markus Levlin	
IX-1-3	Capacity	Patent Agent	

PCT REQUEST

49615

Original (for SUBMISSION) - printed on 30.03.2000 09:34:48 AM

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	

PCT (ANNEX - FEE CALCULATION SHEET)

49615

Original (for **SUBMISSION**) - printed on 30.03.2000 09:34:48 AM

(This sheet is not part of and does not count as a sheet of the international application)

0 0-1	**For receiving Office use only** International Application No.	
0-2	Date stamp of the receiving Office	

0-4 0-4-1	**Form - PCT/RO/101 (Annex)** **PCT Fee Calculation Sheet** Prepared using		PCT-EASY Version 2.90 (updated 08.03.2000)		
0-9	**Applicant's or agent's file reference**		49615		
2	**Applicant**		NOKIA NETWORKS OY, et al.		
12	**Calculation of prescribed fees**		fee amount/multiplier	total amounts (FIM)	
12-1	Transmittal fee	T	⇨	800	
12-2	Search fee	S	⇨	5 618	
12-3	International fee Basic fee (first 30 sheets)	b1	2 431,8		
12-4	Remaining sheets		0		
12-5	Additional amount	(X)	53,51		
12-6	Total additional amount	b2	0		
12-7	b1 + b2 =	B	2 431,8		
12-8	Designation fees Number of designations contained in international application		85		
12-9	Number of designation fees payable (maximum 8)		8		
12-10	Amount of designation fee	(X)	523,22		
12-11	Total designation fees	D	4 185,76		
12-12	PCT-EASY fee reduction	R	-749,16		
12-13	Total International fee (B+D-R)	I	⇨	5 868,4	
12-14	Fee for priority document Number of priority documents requested		1		
12-15	Fee per document	(X)	422		
12-16	Total priority document fee	P	⇨	422	
12-17	**TOTAL FEES PAYABLE (T+S+I+P)**		⇨	12 708,4	
12-19	**Mode of payment**		cheque		

VALIDATION LOG AND REMARKS

13-2-1	**Validation messages** **Request**	Green? A translation of the international application into English will have to be prepared under the responsibility of the ISA selected.

PCT (ANNEX - FEE CALCULATION SHEET) 49615

Original (for **SUBMISSION**) - printed on 30.03.2000 09:34:48 AM

		Green? Please note that the entire request (including the title of invention) must be in English
13-2-6	Validation messages Contents	Green? Reference number for attached copy of general power of attorney not indicated.
13-2-7	Validation messages Fees	Green? Please verify that modified fee amounts are correct.

WO 00/62368
PCT/FI00/00274

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

To:
OULUN PATENTTITOIMISTO
Berggren OY AB
Teknologiantie 14D
FIN-90570 Oulu
FINLANDE

RECEIVED
27. 10. 2000
OULUN PATENTTITOIMISTO

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

Date of mailing (day/month/year) 19 October 2000 (19.10.00)	
Applicant's or agent's file reference OP100014/JUM	**IMPORTANT NOTICE**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/FI00/00274	30 March 2000 (30.03.00)	31 March 1999 (31.03.99)

Applicant
NOKIA NETWORKS OY et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AG,AU,DZ,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,EA,EE,EP,ES,FI,GB,GD,
   GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,
   NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   19 October 2000 (19.10.00) under No. WO 00/62368

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer
J. Zahra

Telephone No. (41-22) 338.83.38

Continuation of Form PCT/IB/308

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

Date of mailing (day/month/year)	IMPORTANT NOTICE
19 October 2000 (19.10.00)	
Applicant's or agent's file reference	**International application No.**
OP100014/JUM	PCT/FI00/00274

The applicant is hereby notified that, at the time of establishment of this Notice, the time limit under Rule 46.1 for making amendments under Article 19 has not yet expired and the International Bureau had received neither such amendments nor a declaration that the applicant does not wish to make amendments.

[redacted]ENT COOPERATION TREAT[redacted]

PCT

30. 03. [illegible]

INTERNATIONAL PRELIMINARY EXAMINATION REPORT [illegible]ISTO

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
~~49615~~ OP100014		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI00/00274	30.03.2000	31.03.1999
International Patent Classification (IPC) or national classification and IPC7		
H 01 P 3/08		
Applicant		
Nokia Networks Oy et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
12.10.2000	12.02.2001
Name and mailing address of the IPEA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Nikolaj Hutaviita/mj Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI00/00274

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language English which is:

☒ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI00/00274

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-7	YES
	Claims		NO
Inventive step (IS)	Claims	1-7	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-7	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The claimed invention relates to a transmission cable.

The transmission cable according to the invention is located in a cavity, comprising a first and a second surface parallel with each other. The transmission cable consisting of a signal cable which is parallel with the first surface, and a ground plane which is mounted on the second surface. The transmission cable also comprises a support element, which has a surface that is located between the first and second surfaces and is parallel with mentioned surfaces. The signal cable is realized by a conductive layer on the surface of the support element.

Documents cited in the International Search Report:

D1 EP, A2, 0 845 831
D2 WO, A1, 93/02485
D3 JP, A, 4-368005
D4 JP, A, 09246814

From D1, a waveguide is known, which comprises a first substrate having a groove therein and a second substrate. The first substrate has a conducting layer on a surface of the groove. The second substrate has a microstrip line on a surface exposed to a cavity in said groove.

From D2, a microstrip line is known, which comprises a dielectric base, an earthing conductor, a conductor strip, and a conductor part. The earthing conductor and the conductor strip are located on opposite surfaces of the dielectric base.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

From D3, a microwave transmission line is known, which comprises a semiconductor board, a ground conductor, a conductor, and a semiconductor board elimination part. The ground conductor and the conductor are located on opposite surfaces of the semiconductor board. The semiconductor board elimination part is located between the conductor and the semiconductor board.

From D4, a high frequency transmission line is known, which comprises a ground conductor, a dielectric board, and a strip conductor. The ground conductor and the strip conductor are located on opposite surfaces of the dielectric board. Grooves are located on the upper surface of the dielectric board, along the strip conductor.

The claimed invention differs from D2-D4 in that the transmission cable is located in a cavity. And D1 does not disclose the feature of mounting the conductive layer on a support element within the cavity. The invention will therefore not be regarded as obvious to a person skilled in the art. Thus, the claimed invention is involving an inventive step.

Accordingly, the claimed invention does fulfill the requirements of novelty (N), the requirements of inventive steps (IS), and the requirements of industrial applicability (IA).

RECEIVED
07. 08. 2000
OULUN
PATENTTITOIMISTO

PCT

[P]ENT COOPERATION TREA[T]

From the INTERNATIONAL BUREAU

To:

BERGGREN OY AB
P.O. Box 16
FIN-00101 Helsinki
FINLANDE

Berggren Oy Ab
26 -07- 2000
MM | ML

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

Date of mailing (day/month/year) 17 July 2000 (17.07.00)	
Applicant's or agent's file reference (49615) OP1000134	**IMPORTANT NOTIFICATION**
International application No. PCT/FI00/00274	International filing date (day/month/year) 30 March 2000 (30.03.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 31 March 1999 (31.03.99)
Applicant NOKIA NETWORKS OY et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An **asterisk(*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
31 Marc 1999 (31.03.99)	990717	FI	26 June 2000 (26.06.00)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Alejandro HENNING

Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

RECEIVED
02. 10. 2000
OULUN PATENTTITOIMISTO

PCT

From the INTERNATIONAL BUREAU

To:

OULUN PATENTTITOIMISTO
Berggren OY AB
Teknologiantie 14D
FIN-90570 Oulu
FINLANDE

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

Date of mailing (day/month/year) 21 September 2000 (21.09.00)	
Applicant's or agent's file reference OP100014/JUM	**IMPORTANT NOTIFICATION**
International application No. PCT/FI00/00274	**International filing date** (day/month/year) 30 March 2000 (30.03.00)

1. The following indications appeared on record concerning:

[ ] the applicant [ ] the inventor [X] the agent [ ] the common representative

Name and Address	State of Nationality	State of Residence
BERGGREN OY AB P.O. Box 16 FIN-00101 Helsinki Finland		
	Telephone No. +358-9-693701	
	Facsimile No. +358-9-6933944	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[X] the person [ ] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address	State of Nationality	State of Residence
OULUN PATENTTITOIMISTO Berggren OY AB Teknologiantie 14D FIN-90570 Oulu Finland		
	Telephone No. +358-8-511 5670	
	Facsimile No. +358-8-556 6701	
	Teleprinter No.	

3. Further observations, if necessary:
Please also note change of agent's file reference, as marked above. Please also note that power of attorney is required from applicant SALMELA.

4. A copy of this notification has been sent to:

[X] the receiving Office
[X] the International Searching Authority
[ ] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Jean-Marie McAdams
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

The demand must be filed directly with the competent International Preliminary Examining Authority. If two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below.

IPEA/ SE

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION

Applicant's or agent's file reference: OP100014/JUM

International application No.	International filing date *(day/month/year)*	(Earliest) Priority date *(day/month/year)*
PCT/FI00/00274	30 March 2000 (30.03.2000)	31 March 1999 (31.03.1999)

Title of invention:
INVERTED MICROSTRIP TRANSMISSION LINE INTEGRATED IN A MULTILAYER STRUCTURE

Box No. II APPLICANT(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

NOKIA NETWORKS OY et al
P.O. Box 300
FIN-00045 Nokia Group
Finland

Telephone No.: +358-9-51121
Facsimile No.: +358-9-51127981
Teleprinter No.:

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
Finland	Finland

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

SALMELA, Olli
Pajalahdentie 9 B 35
FIN-00200 Helsinki
Finland

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
Finland	Finland

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

☐ Further applicants are indicated on a continuation sheet.

International application No.
PCT/FI00/00274

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following person is [x] agent [ ] common representative

and [x] has been appointed earlier and represents the applicant(s) also for international preliminary examination.

[ ] is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.

[ ] is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

OULUN PATENTTITOIMISTO
BERGGREN OY AB
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FIN-90570 Oulu
Finland

Telephone No.: +358-8-5515670

Facsimile No.: +358-8-5566701

Teleprinter No.:

[ ] **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special addr ess to which correspondence should be sent.

Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION

Statement concerning amendments: *

1. The applicant wishes the international preliminary examination **to start on the basis of:**

[x] the international application as originally filed

the description [x] as originally filed
[ ] as amended under Article 34

the claims [x] as originally filed
[ ] as amended under Article 19 (together with any accompanying statement)
[ ] as amended under Article 34

the drawings [x] as originally filed
[ ] as amended under Article 34

2. [ ] The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.

3. [ ] The applicant wishes the start of the international preliminary examination **to be postponed** until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English

[ ] which is the language in which the international application was filed.
[x] which is the language of a translation furnished for the purposes of international search.
[ ] which is the language of publication of the international application.
[ ] which is the language of the translation (to be) furnished for the purposes of international preliminary examination.

Box No. V ELECTION OF STATES

The applicant hereby **elects all eligible States** *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes **not to elect:**

Sheet No. 3

International application No.
PCT/FI00/00274

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

			For International Preliminary Examining Authority use only	
			received	not received
1. translation of international application	:	sheets	☐	☐
2. amendments under Article 34	:	sheets	☐	☐
3. copy (or, where required, translation) of amendments under Article 19	:	sheets	☐	☐
4. copy (or, where required, translation) of statement under Article 19	:	sheets	☐	☐
5. letter	:	sheets	☐	☐
6. other *(specify)*	:	sheets	☐	☐

The demand is also accompanied by the item(s) marked below:

1. [x] fee calculation sheet
2. [ ] separate signed power of attorney
3. [ ] copy of general power of attorney; reference number, if any:
4. [ ] statement explaining lack of signature
5. [ ] nucleotide and or amino acid sequence listing in computer readable form
6. [ ] other *(specify)*:

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

Oulu, 12 October 2000

Antti Räsänen
Patent Attorney
Oulun Patenttitoimisto Berggren Oy Ab

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:
2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):
3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply. ☐ The applicant has been informed accordingly.
4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.
5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

See Notes to the demand form

CHAPTER II

PCT

FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

International application No.	PCT/FI00/00274
Applicant's or agent's file reference	OP100014/JUM

For International Preliminary Examining Authority use only

Date stamp of the IPEA

Applicant

NOKIA NETWORKS OY et al.

Calculation of prescribed fees

1. Preliminary examination fee	SEK 4200	P
2. Handling fee *(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.)*	SEK 1270	H
3. Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box.....	SEK 5470	TOTAL

Mode of Payment

- [ ] authorization to charge deposit account with the IPEA (see below)
- [ ] cheque
- [ ] postal money order
- [x] bank draft

via SWIFT through account 5439-10-013-49

- [ ] cash
- [ ] revenue stamps
- [ ] coupons
- [ ] other *(specify)*:

Deposit Account Authorization *(this mode of payment may not be available at all IPEAs)*

The IPEA/ SE

- [ ] is hereby authorized to charge the total fees indicated above to my deposit account.
- [ ] *(this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

Deposit Account Number | Date *(day/month/year)* | Signature

RECORD COPY

PCT REQUEST

49615

Original (for **SUBMISSION**) - printed on 30.03.2000 09:34:48 AM

0 0-1	**For receiving Office use only** International Application No.	PCT/FI00/00274
0-2	International Filing Date	30 MAR 2000 (30.03.00)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4 0-4-1	**Form - PCT/RO/101 PCT Request** Prepared using	PCT-EASY Version 2.90 (updated 08.03.2000)
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	National Board of Patents and Registration (Finland) (RO/FI)
0-7	**Applicant's or agent's file reference**	49615
I	**Title of invention**	INVERTED MICROSTRIP TRANSMISSION LINE INTEGRATED IN A MULTILAYER STRUCTURE
II II-1 II-2 II-4 II-5 II-6 II-7 II-8 II-9	**Applicant** This person is: Applicant for Name Address: State of nationality State of residence Telephone No. Facsimile No.	applicant only all designated States except US NOKIA NETWORKS OY P.O. Box 300 FIN-00045 Nokia Group Finland FI FI +358-9-51121 +358-9-51168080
III-1 III-1-1 III-1-2 III-1-4 III-1-5 III-1-6 III-1-7	**Applicant and/or inventor** This person is: Applicant for Name (LAST, First) Address: State of nationality State of residence	applicant and inventor US only SALMELA, Olli Pajalahdentie 9 B 35 FIN-00200 Helsinki Finland FI FI

PCT REQUEST

49615

Original (for **SUBMISSION**) - printed on 30.03.2000 09:34:48 AM

IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	BERGGREN OY AB
IV-1-2	Address:	P.O. Box 16 FIN-00101 Helsinki Finland
IV-1-3	Telephone No.	+358-9-693701
IV-1-4	Facsimile No.	+358-9-6933944
IV-1-5	e-mail	email.box@berggren.fi
V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW

PCT REQUEST 49615

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V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	**Exclusion(s) from precautionary designations**	**NONE**	
VI-1	**Priority claim of earlier national application**		
VI-1-1	Filing date	**31 March 1999 (31.03.1999)**	
VI-1-2	Number	**990717**	
VI-1-3	Country	**FI**	
VI-2	**Priority document request** The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	**VI-1**	
VII-1	**International Searching Authority Chosen**	**Swedish Patent Office (ISA/SE)**	
VIII	**Check list**	number of sheets	electronic file(s) attached
VIII-1	Request	**4**	-
VIII-2	Description	**7**	-
VIII-3	Claims	**1**	-
VIII-4	Abstract	**1**	**49615.txt**
VIII-5	Drawings	**3**	-
VIII-7	TOTAL	**16**	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	**diskette**
VIII-18	**Figure of the drawings which should accompany the abstract**	**2**	
VIII-19	**Language of filing of the international application**	**Finnish**	
IX-1	**Signature of applicant or agent**	[signature]	
IX-1-1	Name	**BERGGREN OY AB**	
IX-1-2	Name of signatory	**Markus Levlin**	
IX-1-3	Capacity	**Patent Agent**	

PCT REQUEST

49615

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10-1	**Date of actual receipt of the purported international application**	30 MAR 2000 (30-03-2000)
10-2	**Drawings:**	
10-2-1	Received	
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/SE
10-6	**Transmittal of search copy delayed until search fee is paid**	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	**Date of receipt of the record copy by the International Bureau**	01 MAY 2000 (01.05.00)

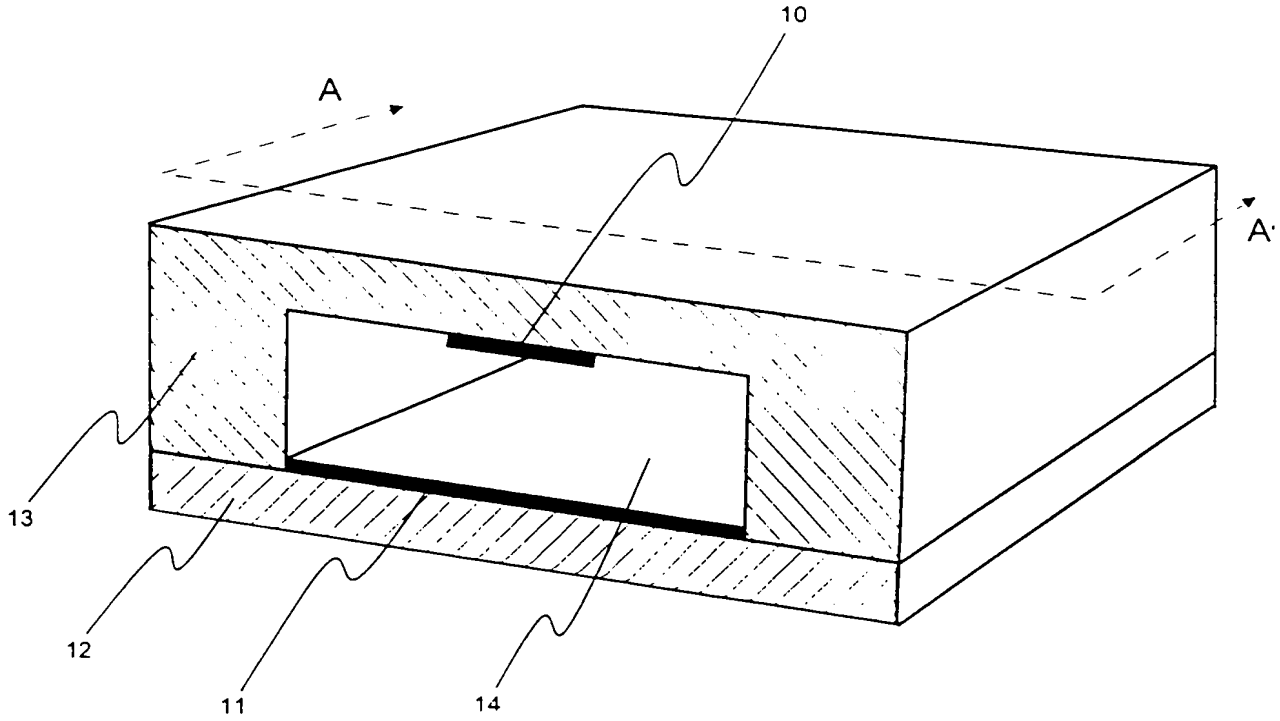

Fig. 1a

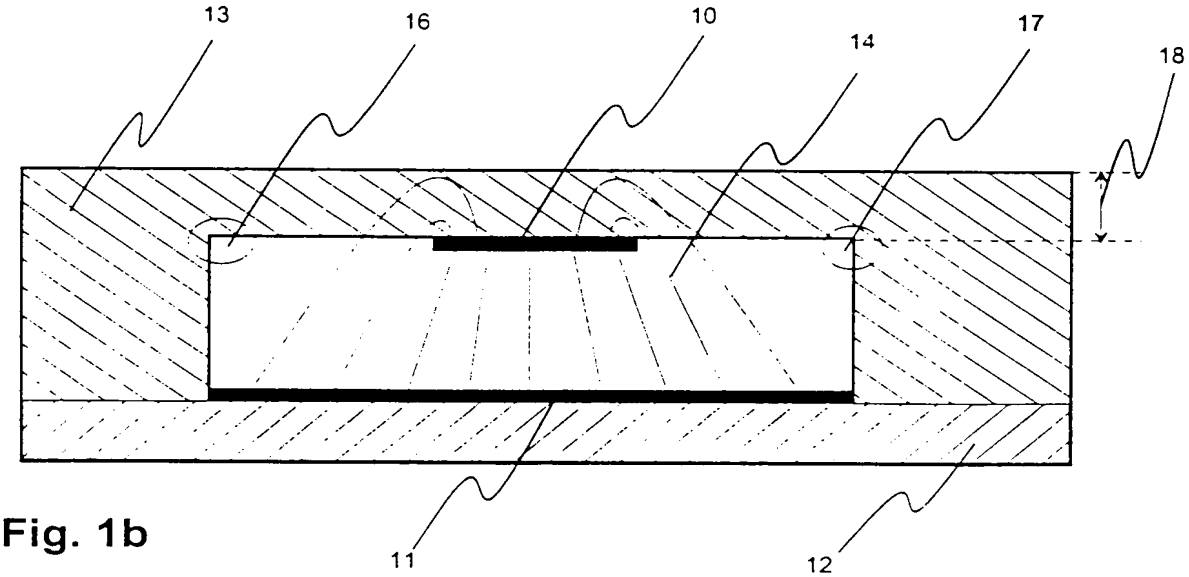

Fig. 1b

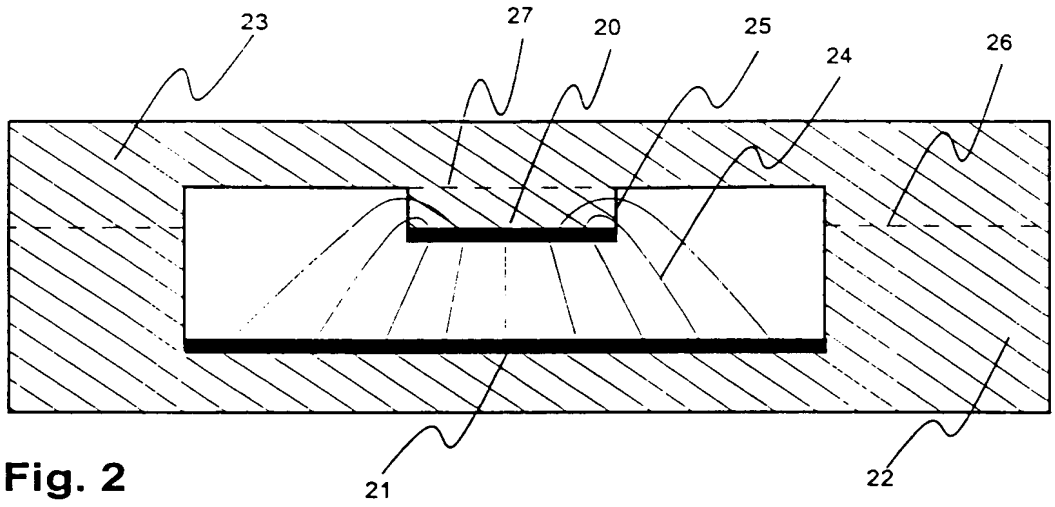

Fig. 2

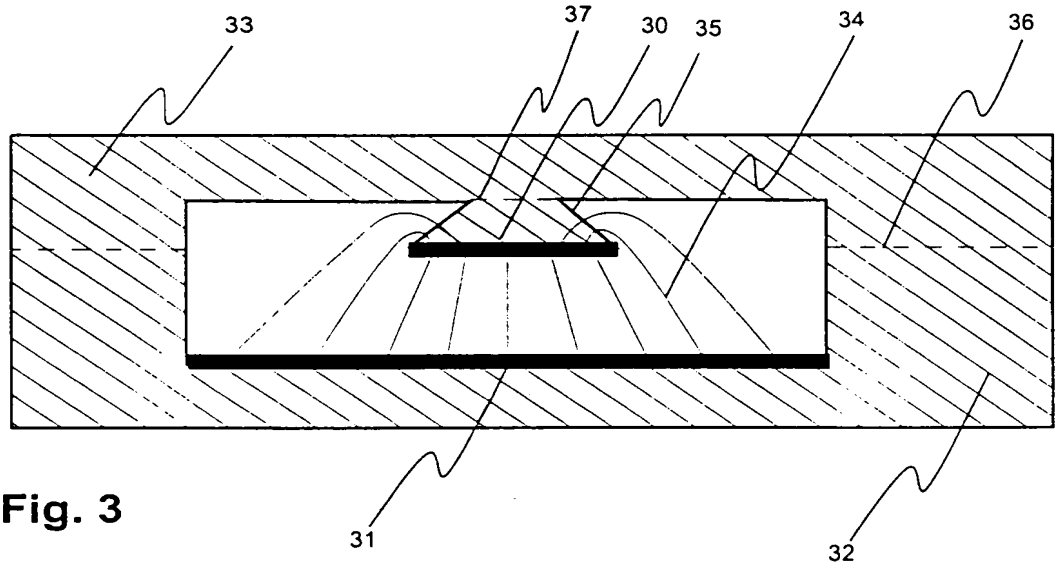

Fig. 3

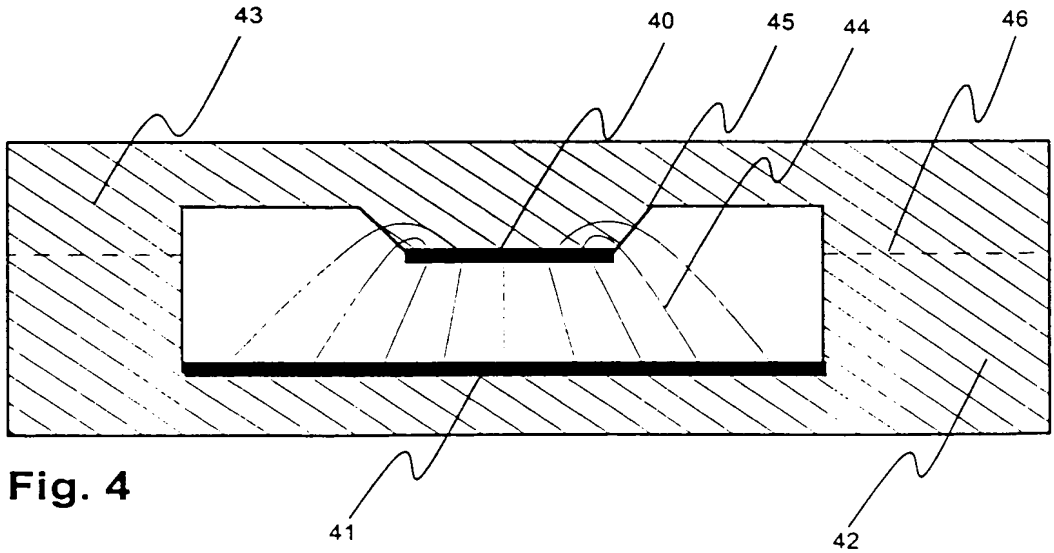

Fig. 4

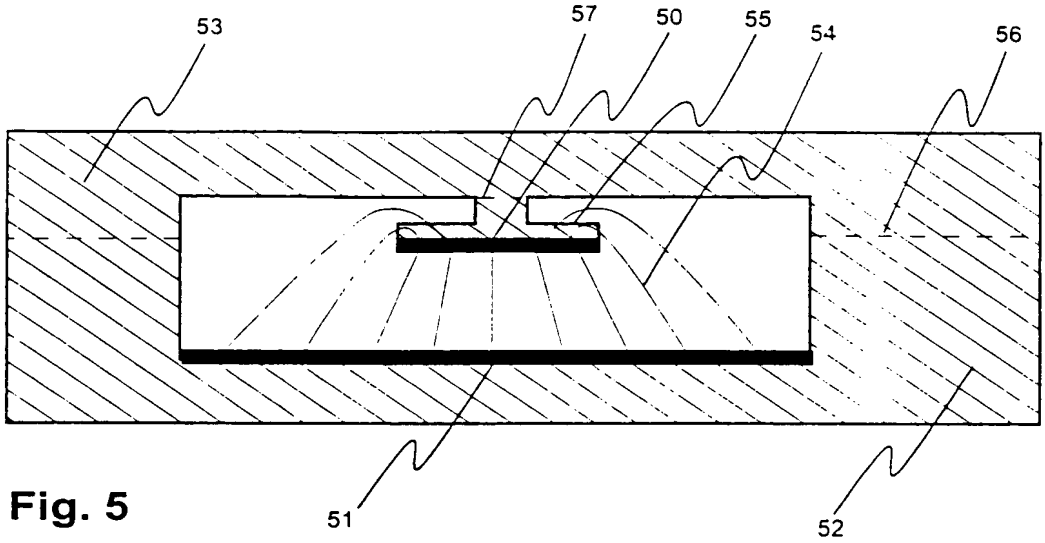

Fig. 5

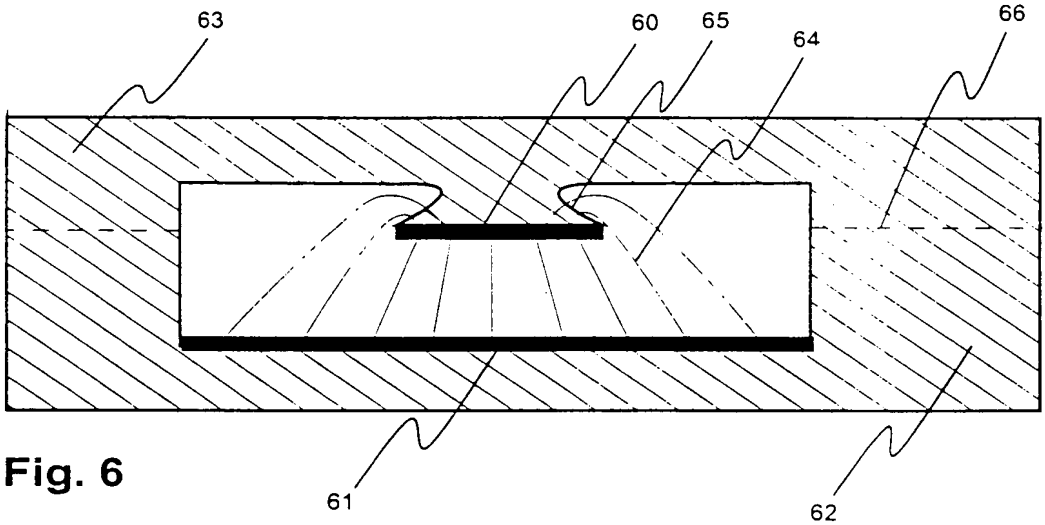

Fig. 6

Invertoitu mikroliuska-siirtolinja monikerrosrakenteeseen integroituna

Keksinnön kohteena on monikerrostekniikalla rakennettu siirtojohto, joka sijaitsee onkalossa, jossa on ensimmäinen pinta ja sen kanssa oleellisesti yhdensuuntainen toinen pinta, ja joka siirtojohto muodostuu signaalijohtimesta, joka on onkalon ensimmäisen pinnan kanssa oleellisesti yhdensuuntainen, ja maajohtimesta, joka on sijoitettu mainitulle toiselle pinnalle oleellisesti yhdensuuntaisesti signaalijohtimen kanssa.

Elektronisten laitteiden rakenteissa käytetään hyväksi erilaisia johtorakenteita. Mitä suurempia taajuuksia laitteissa käytetään, sitä suurempia vaatimuksia asetetaan käytettäville johtorakenteille, jotta johtorakenteiden aiheuttama vaimennus ei kasva liian suureksi. Tätä nykyä käytetään elektronisten laitteiden rakenteissa yleisesti niin sanottua monikerrostekniikkaa, joka perustuu joko HTCC-tekniikkaan (High Temperature Cofired Ceramics) tai LTCC-tekniikkaan (Low Temperature Cofired Ceramics). Molemmilla valmistustavoilla toteutetut rakenteet koostuvat useasta noin 100 μm:n paksuisesta keraamisesta kerroksesta (engl. green tape), jotka on asetettu päällekkäin. Ennen lämpökäsittelyä materiaali on vielä pehmeää, joten keraamisiin kerroksiin voidaan tehdä halutun muotoisia onkaloita. Samoin haluttuihin kohtiin voidaan silkkipainomenetelmällä painaa erilaisia sähköisesti passiivisia elementtejä. Joustavat kerrokset laminoidaan yhteen paineen avulla. Jotta laminointipaine ei romahduttaisi rakennetta, joka sisältää erilaisia onkaloita, joudutaan paineistus tekemään ns. uniaksiaalisesti. Tämä tarkoittaa sitä, että paine kohdistuu kappaleeseen vain kappaleen z-akselin suunnassa. Lopuksi syntynyt rakenne poltetaan LTCC:n tapauksessa 850 asteessa ja HTCC:n tapauksessa 1600 asteessa. Valmistettavissa elementeissä on onkaloiden kohdalle tehty pieniä reikiä, joista polton yhteydessä syntyvä ylipaine purkautuu.

Kuvioissa 1a ja 1b on esitetty eräs mahdollinen tapa toteuttaa edellä kuvatulla tavalla HTCC- tai LTCC-monikerrostekniikkaan perustuva invertoitu mikroliuskajohto. Eräässä mahdollisessa suoritusmuodossa kuvion 1a mukainen rakenne saadaan aikaiseksi liittämällä valmistusprosessissa, kuitenkin ennen rakenteen polttovaihetta, yhteen kuvassa esitetyt esimerkinomaiset osat 12 ja 13. Molemmat mainitut osat on valmistettu kerroksittain jostain sopivasta dielektrisestä aineesta aiemmin kuvatulla tavalla. Osaan 13 on työstetty suorakaiteen muotoinen ura, jonka pohjalle on silkkipainettu signaalijohdin 10. Osan 13 paksuus 18 uran pohjalta mitattuna on niin paksu, ettei häiritseviä maapotentiaalitasoja tule lähelle kuvattua invertoitua mikrolius-

kajohtoa. Osaan 13 tehdyn uran sivuseinämien kulma uran pohjaa vasten 16, 17 on kuvion esimerkissä 90 astetta, mutta periaatteessa kulmat voivat olla muunkin suuruisia. Osan 12 pinnalle on silkkipainettu maadoitusjohdin 11, jonka leveys vastaa osaan 13 tehdyn uran leveyttä. Osat 12 ja 13 on työstetty erikseen ja kun ne liitetään yhteen, saadaan kuvion 1a mukainen rakenne, johon syntyy kaasun täyttämä johto-onkalo 14.

Kuviossa 1b on esitetty kuviosta 1a suuntaan A-A' tehty leikkauskuvanto. Kuvion mukaisen siirtojohdon vaimennuksen ja impedanssin määräävät käytettyjen osien 12 ja 13 permittiivisyys (ε_r) ja uran geometrinen muoto. Kuviosta nähdään, että signaalijohtimesta 10 lähtevä sähkömagneettinen kenttä, jota kuviossa esittävät voimaviivat 15, kulkee pitkän matkaa osan 13 sisällä. Osan 13 permittiivisyys on RF-taajuuksilla selvästi suurempi kuin johto-onkalon 14 täyttävän kaasuseoksen permittiivisyys. Tämä aiheuttaa johdon vaimennuksen kasvamisen voimakkaasti RF-taajuuksilla. Lopulliseen laitteen monikerrosrakenteeseen kuuluu lisäksi myös muita kuin kuvioissa 1a ja 1b esitettyjä aineskerroksia, joihin on voitu työstää passiivisia komponentteja, onkaloita aktiivisia komponentteja varten ja myös muita johtorakenteita.

Edellä kuvatuilla tekniikoilla valmistettujen sähköisten piirien käyttö tulee kuitenkin ongelmalliseksi, jos joudutaan käyttämään hyvin korkeita taajuuksia (RF-sovellukset). Signaalin vaimennus LTCC-tekniikalla toteutetussa johtorakenteessa 20 GHz:n taajuudella nousee 0,2 dB/cm ja HTCC-tekniikalla toteutetussa johtorakenteessa 0,6 dB/cm. Sellaisissa RF-sovelluksissa, joissa vaaditaan pientä vaimennusta, kuten esimerkiksi suodattimet ja suuren hyvyysluvun (Q-arvon) omaavat värähtelylähteet, eivät edellä mainitut tekniikat enää ole käyttökelpoisia.

Toinen ongelma käytettäessä tavanomaisia mikroliuskajohtoja tai invertoituja mikroliuskajohtoja on rakenteilla aikaansaatavien siirtojohtojen impedanssitaso. Impedanssitason hallitsematon vaihtelu saa aikaan signaalin epätoivottuja heijastumia takaisin tulosuuntaansa tai säteilyä johtimen ympäristöön. Impedanssiin vaikuttaa johtorakenteen geometrinen muoto sekä ympäröivien aineskerrosten suhteellinen permittiivisyys (ε_r). Tekniikan tason mukaisissa rakenteissa vapausasteita impedanssin sovittamiseksi ei ole muita kuin edellä mainitut kaksi tekijää.

Tekniikan tason mukaisilla LTCC- ja HTCC-rakenteilla nousee ongelmaksi myöskin vaihenopeuden dispersio suurilla taajuuksilla. Dispergoituneessa signaalissa sen eri taajuuksilla olevat signaalikomponentit ovat kulkeneet siirtojohdon läpi eri nope-

uksilla. Ilmiö vääristää vastaanotettua signaalia, ja dispersion liiallinen kasvu johtaa vastaanotetun signaalin muuttumiseen käyttökelvottomaksi.

Patenttijulkaisusta US 3 904 997 tunnetaan ratkaisu, jossa substraatin päällä lepäävän invertoidun mikroliuskajohtimen signaalijohdin ympäröidään metallista valmistetulla kotelomaisella rakenteella. Ratkaisulla on pyritty pienentämään sekä siirtojohdon vaimennusta että myös johdosta karkaavaa hajasäteilyä. Metallinen johto-onkalo joudutaan aina valmistamaan erikseen, ja sen kiinnittäminen luotettavasti muuhun monikerrosrakenteeseen tuottaa ongelmia. Metallisen johto-onkalon erilainen lämpölaajenemiskerroin perussubstraatin kanssa voi aiheuttaa rakenteen hajoamisen liitospinnasta. Rakenne sisältää lisäksi paljon erilaisia käsin tehtäviä työvaiheita, joten se on myös valmistuskustannuksiltaan kallis.

Patenttijulkaisusta US 5 105 055 tunnetaan ratkaisu, jossa samaan joustavaan, kaapelimaiseen rakenteeseen on integroitu useita johtimia. Rakenteessa signaalijohdin on kiinnitetty dielektriseen substraattiin ja maajohdin sijaitsee toisesta dielektrisestä aineesta muodostetussa onkalomaisessa rakenteessa. Kaapeli on periaatteelliselta ratkaisultaan useasta invertoidusta mikroliuskajohdosta koostuva kokonaisuus. Kaapelirakenteen materiaalit on valittu aineista, jotka ovat taipuisia, ja niitä voidaan työstää muovien työstämiseen tarkoitetuilla ekstruusiolaitteilla. Kaapelin rakennetta on julkaisussa varioitu useilla eri tavoilla. Julkaisun mukaan kaapeli on tarkoitettu käytettäväksi henkilökohtaisten PC-laitteiden kanssa. Käyttökohteesta johtuen rakenteeseen valitut materiaalit eivät tässäkään tapauksessa mahdollista RF-taajuuksien käyttämistä.

Keksinnön tarkoituksena on vähentää mainittuja tekniikan tasoon liittyviä haittoja.

Keksinnön mukaiselle onkaloon sijoitetulle siirtojohdolle on tunnusomaista, että se käsittää kannakeosan, jolla on pinta, joka on olennaisesti yhdensuuntainen onkalon ensimmäisen ja toisen pinnan kanssa ja joka on mainitun ensimmäisen ja toisen pinnan välissä, jolloin signaalijohdin on toteutettu kannakeosan pinnalle muodostetun sähköä johtavan materiaalikerroksen avulla.

Keksinnön eräitä edullisia suoritusmuotoja on esitetty epäitsenäisissä patenttivaatimuksissa.

Keksinnön perusajatus on seuraava: Valmistetaan monikerrostekniikalla modifioitu, invertoitu mikroliuskajohto, jossa signaalijohdin kiinnitetään muotoillun kannakeosan avulla johto-onkalon yhdelle pinnalle. Näin saadaan johtoa ympäröivien aines-

kerrosten vaikutusta johtimen ympärillä olevaan sähkömagneettiseen kenttään pienennettyä huomattavasti.

Keksinnön etuna on se, että keksinnön mukaisen siirtojohdon vaimennus on RF-taajuuksilla selvästi pienempi kuin olemassa olevilla invertoiduilla mikroliuskajohdoilla, koska signaalijohtimesta lähtevä sähkömagneettinen kenttä on pääosin kaasun täyttämässä johto-onkalossa, jonka permittiivisyys (ε_r) on pieni verrattuna ympäröivien dielektristen materiaalien permittiivisyyteen.

Lisäksi keksinnön etuna on se, että siirtojohto voidaan täysin integroida monikerrosrakenteeseen ilman mitään erityisiä, sitä varten tehtäviä, työvaiheita.

Edelleen keksinnön etuna on se, että sen avulla voidaan siirtojohdon impedanssitaso sovittaa halutuksi yksinkertaisesti.

Seuraavassa keksintöä selostetaan yksityiskohtaisesti. Selostuksessa viitataan oheisiin piirustuksiin, joissa

kuvio 1a esittää perspektiivikuvantona tekniikan tason mukaista monikerrostekniikalla toteutettua invertoitua mikroliuskajohtoa,

kuvio 1b esittää leikkauskuvantoa kuvion 1a siirtojohdosta suuntaan A-A',

kuvio 2 esittää leikkauskuvantona erästä keksinnön mukaista suoritusmuotoa,

kuvio 3 esittää leikkauskuvantona toista keksinnön mukaista suoritusmuotoa,

kuvio 4 esittää leikkauskuvantona kolmatta keksinnön mukaista suoritusmuotoa,

kuvio 5 esittää leikkauskuvantona neljättä keksinnön mukaista suoritusmuotoa,

kuvio 6 esittää leikkauskuvantona viidettä keksinnön mukaista suoritusmuotoa.

Kuviot 1a ja 1b on esitetty tekniikan tason kuvauksen yhteydessä.

Kuvioissa 2-6 on esitetty eräitä edullisia keksinnön mukaisia suoritusmuotoja. Kaikki kuvioissa esitetyt suoritusmuodot koostuvat monikerrostekniikalla valmistetuista osista, jotka ovat liitettävissä valmistusprosessissa yhtenäiseksi rakenteeksi. Kuviossa 2 esitetyssä eräässä keksinnön mukaisessa suoritusmuodossa on invertoidun mikroliuskajohdon signaalijohdin 20 kiinnitetty keksinnön mukaiseen kannakeosaan 25. Siirtojohtoa ympäröivät seinämät voidaan valmistaa tekniikan tason kuvauksen yhteydessä kuvatulla prosessilla esimerkiksi kahdesta tai useammasta osasta

22 ja 23, jotka kummatkin koostuvat useasta keraamisesta kerroksesta. Osien kuviota vasten kohtisuora leikkauspinta 26 valitaan siten, että valmistusprosessissa päästään mahdollisimman vähillä työvaiheilla. Myös kannakeosa 25 voidaan tehdä usealla vaihtoehtoisella tavalla. Se voidaan esimerkiksi tehdä siten, että osien 22 ja 23 rajapinta on juuri kannakeosan pinnan tasolla, joka kuviossa on esitetty katkoviivalla 26. Molemmin puolin kannakeosaa 25 valmistetaan kuviossa näkyvät urat.

Toinen vaihtoehto on tehdä ura osaan 23 kuvion 1a yhteydessä esitetyllä tavalla ja valmistaa kannakeosa 25 ja signaalijohdin 20 erikseen leikkaustasosta lähtien kuviossa esitetystä leikkaustasosta, jota kuvaa katkoviiva 27. Kannakeosa 25 ja signaalijohdin 20 liitetään myöhemmissä valmistusvaiheissa yhtenäisenä rakenteena osaan 23 tehdyn uran pohjalle. Maajohdin 21 on valmistettu joko kuvion 1a selityksessä esitettyyn tapaan tai se voidaan silkkipainaa myös kappaleessa 22 olevaan sopivan kokoiseen uraan, jos osien 22 ja 23 rajapinta on kuviossa katkoviivalla 26 esitetty taso. Kun osat 22, 23 ja kannakeosa 25 liitetään yhteen, sijoittuu maajohdin 21 johto-onkaloon yhdensuuntaisesti signaalijohdon 20 kanssa. Kuviosta nähdään, että signaalijohtimesta 20 kohti maajohdinta 21 lähtevä sähkömagneettinen kenttä, jota kuviossa kuvaavat voimaviivat 24, kulkee selvästi lyhyemmän matkaa dielektrisessä aineessa, kannakeosassa 25, kuin mitä se joutuu kulkemaan kuvion 1b tapauksessa dielektrisestä aineesta koostuvan osan 13 sisällä. Siirtojohdon häviöistä suurin osa muodostuu juuri häviöistä dielektrisessä ainekerroksessa. Tämän seurauksena keksinnön mukaisella invertoidulla mikroliuskajohdolla on pienempi vaimennus pituusyksikköä kohden kuin tekniikan tason mukaisella invertoidulla mikroliuskajohdolla. Keksinnön mukaisen siirtojohdon impedanssitaso voidaan tehdä halutun suuruiseksi, koska dielektrisestä aineesta muodostuvan kannakeosan 25 ulkomittoja muuttamalla vaikutetaan siirtojohdon impedanssiin.

Kuviossa 3 esitetyssä suoritusmuodossa invertoidun mikroliuskajohdon signaalijohdin 30 on kiinnitetty kolmiomaisesti siirtojohto-ontelon pohjaa kohden kapenevaan kannakeosaan 35. Kuvion mukainen johtorakenne koostuu ainakin kahdesta erillisestä osasta 32 ja 33. Osien rajapinta, joka on esitetty kuviossa katkoviivalla 36, valitaan rakenteen valmistamisen kannalta parhaaksi mahdolliseksi. Osien 32 ja 33 rajapinta 36 voi olla, kuten kuviossa on esitetty, kannakeosaan 35 kiinnitetyn signaalijohtimen taso 30 mutta se voi olla jokin muukin taso. Kannakeosa 35 voidaan tehdä osan 33 valmistuksen yhteydessä mutta se voi olla valmistettu myös erikseen, jolloin sen liitospinta osaan 33 voi olla taso, joka kuviossa on esitetty katkoviivalla 37. Signaalijohtimesta 30 kohden maajohdinta 31 lähtevästä sähkömagneettisesta kentästä, jota kuviossa kuvaavat voimaviivat 34, kulkee osa lyhyen mat-

kaa kannakeosan 35 sisällä. Kannakeosan sisälle jäävä sähkömagneettisen kentän osa on pienempi kuin kuviossa 1b esitetyn tekniikan tason mukaisessa ratkaisussa pohjasubstraattiin jäävä osa. Kuvion esittämän suoritusmuodon vaimennus pituusyksikköä kohden on täten pienempi kuin tekniikan tason mukaisen invertoidun mikroliuskajohdon vaimennus.

Kuviossa 4 esitetyssä suoritusmuodossa on invertoidun mikroliuskajohdon signaalijohdin 40 kiinnitetty osaan 43 tehdyn uran pohjaa kohden levenevään kannakeosaan 45. Kuvion mukainen rakenne koostuu ainakin kahdesta erillisestä osasta 42 ja 43. Osia on työstetty niin, että niiden sisälle on muodostunut kuvion mukainen johtoonkalo. Osien 42 ja 43 rajapinta, joka on esitetty kuvassa katkoviivalla 46, valitaan kappaleen valmistuksen kannalta parhaaksi mahdolliseksi. Osien 42 ja 43 rajapinta 46 voi olla, kuten kuviossa on esitetty, kannakeosaan 45 kiinnitetyn signaalijohtimen 40 taso mutta se voi olla jokin muu osien valmistuksen kannalta hyvä taso. Tässä suoritusmuodossa osa signaalijohtimesta 40 kohden maajohdinta 41 lähtevästä sähkömagneettisesta kentästä, jota kuviossa kuvaavat voimaviivat 44, kulkee kannakeosan 45 läpi. Kannakeosan läpi menevä sähkömagneettisen kentän osa on kuitenkin selvästi pienempi kuin kuvion 1b mukaisessa tekniikan tason mukaisessa invertoidun mikroliuskajohdon tapauksessa. Näin ollen tämänkin suoritusmuodon vaimennus pituusyksikköä kohden on tekniikan tason mukaista siirtojohtoa parempi.

Kuviossa 5 esitetyssä suoritusmuodossa on invertoidun mikroliuskajohdon signaalijohdin 50 kiinnitetty T-palkin muotoiseen kannakeosaan 55. Siirtojohtoa ympäröivät seinämät koostuvat ainakin kahdesta osasta 52 ja 53, joiden kuviota vasten kohtisuora leikkauspinta, jota esittää katkoviiva 56, valitaan siten, että osien valmistusvaiheessa päästään mahdollisimman vähillä työvaiheilla. Kannakeosa 55 voidaan tehdä vaihtoehtoisilla tavoilla. Yksi vaihtoehto on valmistaa kannakeosa 55 ja signaalijohdin 50 erikseen T-palkin juuressa olevasta tasosta lähtien, jota kuviossa esittää katkoviiva 57. Kannakeosa 55 ja signaalijohdin 50 liitetään yhtenäisenä rakenteena osaan 52. Maajohdin 51 voidaan valmistaa esimerkiksi kuvion 1b yhteydessä esitetyllä tavalla. Kun osat 52, 53 ja 55 liitetään yhteen, maajohdin 51 sijoittuu johtoonkaloon vastakkaiselle puolelle signaalijohdinta 50. Kuviosta nähdään, että signaalijohtimesta 50 kohti maajohdinta 51 lähtevä sähkömagneettinen kenttä, jota kuviossa kuvaavat voimaviivat 54, kulkee vain lyhyen matkaa dielektrisessä aineessa, kannakeosassa 55. Tämän seurauksena kuvion mukaisella invertoidulla mikroliuskajohdolla on erittäin pieni vaimennus pituusyksikköä kohti verrattuna tekniikan tason mukaisen invertoidun mikroliuskajohdon vaimennukseen.

Kuviossa 6 esitetyssä suoritusmuodossa siirtojohtorakenne muodostuu ainakin kahdesta osasta 62 ja 63. Osien välinen rajapinta, jota kuviossa esittää katkoviiva 66, on valittu valmistuksen kannalta sopivaksi. Se voi olla kuviossa esitetyllä kohdalla, jolloin se on kannakeosan 65 pinnan tasalla, jota kuviossa esittää katkoviiva 66. Kannakeosan muoto on tässä suoritusmuodossa sisäänpäin kaareva. Kannakeosa 65 kuuluu yhtenä osana osaan 63. Tässäkin suoritusmuodossa signaalijohtimesta 60 lähtevästä sähkökentästä, jota kuviossa esittävät voimaviivat 64, pieni osa kulkee kannakeosan dielektrisessä aineessa. Myös tässä suoritusmuodossa keksinnön mukaisen invertoidun mikroliuskajohdon vaimennus on pieni verrattuna tekniikan tason mukaiseen vastaavaan siirtojohtoon.

Edellä kuvatuissa suoritusmuodoissa keksinnön mukainen invertoitu mikroliuskajohto on sijoitettu dielektrisistä ainekerroksista muodostettuun johto-onkaloon. Johto-onkalon seinämän muodostavien kerrosten lukumäärä voi vaihdella käytettävän tekniikan ja optimaalisten työvaiheiden lukumäärän mukaisesti. Syntyvän johto-onkalon seinämien vahvuuksien oletetaan olevan joka suuntaan niin suuria, että ympäristössä mahdollisesti olevat muut maapotentiaalitasot sijaitsevat niin kaukana, ettei siirtojohdon sähkömagneettisen kentän muoto häiriinny niiden takia.

Keksintö ei rajoitu juuri kuvattuihin suoritusmuotoihin. Esimerkiksi johto-onkalon muodostavien seinämien rakenne on jaettavissa erilaisiin tasoihin lukemattomilla erilaisilla tavoilla. Käytettävä valmistustekniikka määrää, mikä muodostettavien seinämien osien jakotapa on kustannuksien ja saannon kannalta optimaalinen. Samoin keksinnön mukainen kannakeosa voi poiketa muodoltaan esitetyistä edullisista suoritusmuodoista. Myöskin käytettävien signaali- ja maajohtimien valmistustapa voi olla muu kuin edellä esitetty silkkipainomenetelmä. Rakenteessa käytettävänä johtona voidaan käyttää myös muita tunnettuja johtorakenteita, kuten esimerkiksi koplanaarijohtoa. Keksinnöllistä ajatusta voidaan soveltaa lukuisilla tavoilla patenttivaatimusten asettamissa rajoissa.

Patenttivaatimukset

1. Monikerrostekniikalla rakennettu siirtojohto, joka sijaitsee onkalossa, jossa on ensimmäinen pinta ja sen kanssa oleellisesti yhdensuuntainen toinen pinta, ja joka siirtojohto muodostuu signaalijohtimesta (20, 30, 40, 50, 60), joka on onkalon ensimmäisen pinnan kanssa oleellisesti yhdensuuntainen, ja maajohtimesta (21, 31, 41, 51, 61), joka on sijoitettu mainitulle toiselle pinnalle oleellisesti yhdensuuntaisesti signaalijohtimen kanssa, **tunnettu** siitä, että se lisäksi käsittää kannakeosan (25, 35, 45, 55, 65), jolla kannakeosalla on pinta, joka on olennaisesti yhdensuuntainen mainitun ensimmäisen ja toisen pinnan kanssa ja joka on mainitun ensimmäisen ja toisen pinnan välissä, jolloin signaalijohdin on toteutettu kannakeosan pinnalle muodostetun sähköä johtavan materiaalikerroksen avulla.

2. Patenttivaatimuksen 1 mukainen siirtojohto, **tunnettu** siitä, että mainittu kannakeosa (25, 35, 45) on muodoltaan nelikulmio.

3. Patenttivaatimuksen 1 mukainen siirtojohto, **tunnettu** siitä, että kannakeosa on suorakulmio (25).

4. Patenttivaatimuksen 1 mukainen siirtojohto, **tunnettu** siitä, että kannakeosa on muodoltaan T-palkki (55).

5. Patenttivaatimuksen 1 mukainen siirtojohto, **tunnettu** siitä, että kannakeosa on muodoltaan kahden kaarevan pinnan muodostama pinta (65).

6. Patenttivaatimuksen 1 mukainen siirtojohto, **tunnettu** siitä, että signaalijohdin on invertoitu mikroliuskajohdin.

7. Patenttivaatimuksen 1 mukainen siirtojohto, **tunnettu** siitä, että signaalijohto on koplanaarijohto.

(57) Tiivistelmä

Keksinnön kohteena on monikerrostekniikalla toteutettu siirtojohto, jossa signaalijohdin (20) on asetettu halutun etäisyyden päähän siirtojohdolle rakennetun johto-onkalon seinämästä erillisen kannakeosan (25) avulla. Rakenteeseen kuuluva maajohdin (21) on signaalijohdinta vastaapäätä sijaitsevalla johto-onkalon seinämällä. Keksinnön mukaisella siirtojohdolla saavutetaan pieni vaimennus pituusyksikköä kohden RF-taajuuksilla.

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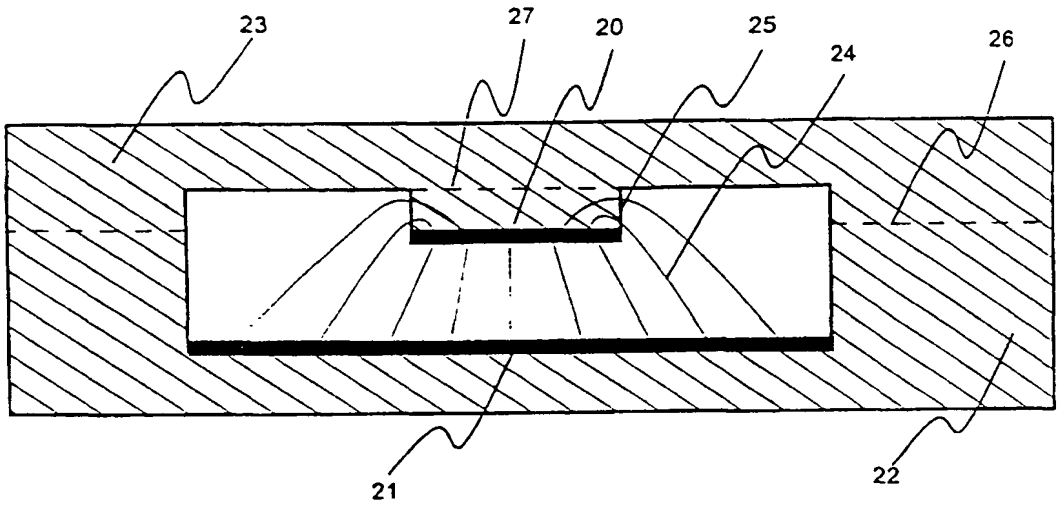

(57) Abstract

The invention relates to a transmission cable realised by multilayer technique, where the signal cable (20) is set at a desired distance from the wall of the cavity constructed for said transmission cable by means of a separate support element (25). The ground cable (21) included in the structure is placed on the cable cavity wall opposite to the signal cable. By using the transmission cable according to the invention, there is achieved a low attenuation per unit of length at RF frequencies.

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Inverted microstrip transmission line integrated in a multilayer structure

The invention relates to a transmission cable constructed by multilayer technique, said cable being located in a cavity with a first surface and a second surface essentially parallel to the first, said transmission cable consisting of a signal cable that is essentially parallel with the first surface of the cavity, and of a ground cable that is placed on said second surface, essentially in parallel with the signal cable.

Various different cable structures are utilised in the construction of electronic appliances. The higher the employed frequencies, the higher the requirements set for the cable structures to be used, in order to prevent attenuation caused by said cable structures. At present, in the structures of electronic appliances, there is generally applied the so-called multilayer technique, which is based either on the HTCC technique (High Temperature Cofired Ceramics) or on the LTCC technique (Low Temperature Cofired Ceramics). With both manufacturing methods, the produced structures consist of several green tapes, with a thickness of about 100 μm, which are positioned one on top of the other. Prior to thermal treatment, the material still is soft, so that in the green tapes, there can be made cavities of desired shapes. Likewise, at desired spots, there can be silk-screened various electrically passive elements. The elastic layers are laminated together by means of pressure. In order to prevent the lamination pressure from collapsing the structure that contains various cavities, the pressurising must be carried out according to a so-called unaxial method. This means that the pressure is directed to the object only in the direction of the axis z of said object. Finally the created structure is burnt, in the case of LTCC at 850 degrees and in the case of HTCC at 1,600 degrees. In the elements to be produced, at the cavities there are made perforations through which the excess pressure created in the burning process can be let out.

In figures 1a and 1b, there is illustrated a possible alternative for realising an inverted microstrip cable based on the HTCC or LTCC multilayer technique according to the description above. In a preferred embodiment, the structure according to figure 1a is achieved by joining together, during the production process but prior to the burning step of the structure, the exemplary elements 12 and 13 illustrated in the drawing . Both of said elements are made layer by layer of some suitable dielectric material in a fashion described above. In the element 13, there is machined a rectangular groove, on the bottom of which there is silk-screened a signal cable 10. The thickness 18 of the element 13, when measured at

the bottom of the groove, is sufficient to prevent disturbing ground potential levels from coming close to the described inverted microstrip cable. In the example illustrated in the drawing , the angle between the side walls of the groove made in the element 13 and the groove bottom 16, 17 is 90 degrees, but in principle the angles can have some other size, too. On the surface of the element 12, there is silk-screened a ground cable 11, the width whereof corresponds to the width of the groove made in the element 13. The elements 12 and 13 are machined separately, and when they are connected, there is obtained a structure according to figure 1a, where there is created a gas-filled cable cavity 14.

In figure 1b, there is illustrated a cross-section made in the direction A - A' of figure 1a. The attenuation and impedance of a transmission cable according to the invention are determined by the permittivity (ε_r) of the employed elements 12 and 13, as well as the geometric shape of the groove. From the drawing it is seen that the electromagnetic field emitted from the signal cable 10, said field in the drawing being illustrated by the power lines 15, proceeds a long way inside the element 13. With RF frequencies, the permittivity of the element 13 is clearly higher than the permittivity of the gas mixture filling the cable cavity 14. This results in that the cable attenuation is strongly increased with RF frequencies. The final multilayer structure of the apparatus also includes other material layers than those illustrated in figures 1a and 1b, in which layers there may be provided passive components, cavities for active components and other cable structures, too.

However, the use of electric circuits manufactured by the above described techniques becomes problematic, if very high frequencies must be used (RF applications). Signal attenuation in a cable structure realised with LTCC technique at the frequency of 20 GHz rises up to 0,2 dB/cm, and in a cable structure realised with HTCC technique up to 0,6 dB/cm. In such RF applications where low attenuation is required, for example in filters and oscillation sources having a high quality factor (Q value), the above described techniques are no longer feasible.

Another problem with regular microstrip cables or inverted microstrip cables is the impedance level of the transmission cables realised by means of structures. An uncontrolled fluctuation of the impedance level results in undesired reflections of the signal back in the direction where the signal came from, or in radiation in the cable surroundings. Impedance is affected by the geometric shape of the cable structure, as well as by the relative permittivity (ε_r) of the surrounding material layers. In prior art structures, the above described two factors are the only free choices for adjusting the impedance.

With prior art LTCC and HTCC structures, another drawback is presented in the dispersion of the phase velocity with high frequencies. In a dispersed signal, the signal components contained therein at different frequencies have passed through the transmission cable at different velocities. This phenomenon distorts the received signal, and an excessive increase of the dispersion results in that the received signal becomes inapplicable.

From the US patent publication 3,904,997 there is known an arrangement where the signal cable of an inverted microstrip resting on a substrate is encased in a shell-like structure made of metal. By means of this arrangement, both the attenuation of the transmission cable and the stray radiation scattered from the cable are attempted to be reduced. The metallic cable cavity must always be manufactured in advance, and its fastening in a reliable way to the rest of the multilayer structure causes problems. The fact that the thermal expansion coefficient of the metallic cable cavity is different from the basic substrate may cause the structure to break at the junction surface. Moreover, the structure includes a lot of manually performed work steps, wherefore it also is expensive in manufacturing costs.

From the US patent publication 5,105,055 there is known an arrangement where in one flexible, cable-like structure there are integrated several cables. In said structure, the signal cable is attached to a dielectric substrate, and the ground cable is placed in a cavity-like structure made of another dielectric material. In principle, said cable is an entity made of several inverted microstrip cables. The materials of the cable structure are chosen among such materials that are elastic, and they can be processed with extrusion devices designed for processing plastics. Several variations of the cable structure are presented in the publication. According to said publication, the cable is meant to be used in connection with personal PC devices. Also in this case it is pointed out that owing to the target of usage, the materials chosen in the structure do not enable the use of RF frequencies.

The object of the invention is to reduce the described drawbacks connected to the prior art.

The transmission cable placed in a cavity according to the invention is characterised in that it comprises a support element with a surface essentially parallel to the first and second surfaces of the cavity, said support element being placed between said first and second surfaces, so that the signal cable is realised by

means of an electroconductive material layer formed on the surface of said support element.

A number of preferred embodiments of the invention are set forth in the independent claims.

The basic principle of the invention is as follows: by applying multilayer technique, there is manufactured a modified, inverted microstrip cable, where the signal cable is attached, by means of a specially designed support element, on one surface of the cable cavity. Thus the effect of the material layers that encase the cable to the electromagnetic field surrounding said cable is remarkably reduced.

An advantage of the invention is that at RF frequencies the attenuation of a transmission cable according to the invention is clearly lower than with existing inverted microstrip cables, because the electromagnetic field emitted from the signal cable is mainly located in the gas-filled cable cavity, the permittivity (ε_r) of said cable cavity with respect to the permittivity of the surrounding dielectric materials being low.

Another advantage of the invention is that the transmission cable can be fully integrated in a multilayer structure without any specific work steps carried out expressly for this purpose.

Yet another advantage of the invention is that thereby the impedance level of the transmission cable can be adjusted as desired in a simple fashion.

The invention is explained in more detail below. The description refers to the accompanying drawings, wherein

figure 1a shows in a perspective illustration a prior art inverted microstrip cable realised by multilayer technique,

figure 1b shows a cross-section of the transmission cable of figure 1a, seen along the line A - A',

figure 2 shows in cross-section a preferred embodiment according to the invention,

figure 3 shows in cross-section another preferred embodiment according to the invention,

figure 4 shows in cross-section a third preferred embodiment according to the invention,

figure 5 shows in cross-section a fourth preferred embodiment according to the invention, and

figure 6 shows in cross-section a fourth preferred embodiment according to the invention,

Figures 1a and 1b were already dealt with in connection with the description of the prior art.

Figures 2 - 6 represent a few preferred embodiments according to the invention. All embodiments illustrated in the drawings consist of elements manufactured by multilayer technique, which elements can in the manufacturing process be combined to form a uniform structure. In the preferred embodiment of the invention illustrated in figure 2, the signal cable 20 of an inverted microstrip cable is attached to a support element 25 according to the invention. The walls surrounding the transmission cable can be made in a process explained above, in connection with the description of the prior art, for instance of two or more elements 22 and 23, which both are compiled of several green tapes. The sectional plane 26 of the elements, perpendicular to the patterns, is chosen so that the number of work steps in the manufacturing process is minimised. The support element 25 can likewise be made in several alternative ways. For example, it can be made so that the contact surface of the elements 22 and 23 is placed exactly on the level of the support element surface, which in the drawing is illustrated by a dotted line 26. On both sides of the support element 25, there are made grooves seen in the illustration.

Another alternative is to make a groove in the element 23 according to the method described in connection with figure 1a and to manufacture the support element 25 and the signal cable 20 separately with respect to the sectional plane, starting from the sectional plane illustrated by the dotted line 27. The support element 25 and the signal cable 20 are in later manufacturing steps attached, as a uniform structure, on the bottom of the groove made in the element 23. The ground cable 21 is made either in the way described in connection with figure 1a, or it may be silk-screened in a groove of a suitable size provided in the element 22, if the contact surface of the elements 22 and 23 is the plane illustrated by the dotted line 26. When the elements 22, 23 and the support element 25 are connected, the ground cable 21 is

placed in the cable cavity in parallel with the signal cable 20. From the drawing it is seen that the electromagnetic field emitted from the signal cable 20 towards the ground cable 21, said field being illustrated by the power lines 24, clearly makes a shorter passage in the dielectric material, in the support element 25, than it has to make in the case of figure 1b, inside the element 13 made of a dielectric material. The major part of the transmission cable losses are composed exactly of the losses made in the dielectric material layer. As a consequence, the inverted microstrip cable according to the invention has a smaller attenuation per unit of length than the inverted microstrip cable according to the prior art. However, the impedance level of the transmission cable according to the invention can be adjusted to the desired magnitude, because the impedance of the transmission cable is affected by adjusting the outer dimensions of the support element 25 made of some dielectric material.

In the embodiment illustrated in figure 3, the signal cable 30 of an inverted microstrip cable is attached to a support element 35, which is narrowed in a triangular fashion towards the bottom of the transmission cable cavity. The cable structure according to the drawing is composed of at least two separate elements 32 and 33. The contact surface of the elements, which in the drawing is illustrated by the dotted line 36, is chosen to be the best possible with respect to the manufacturing of the structure. The contact surface 36 of the elements 32 and 33 can be, as is illustrated, the plane 30 of the signal cable attached to the support element 35, but it can also be some other plane. The support element 35 can be produced in connection with the production of the element 33, but it can also be produced separately, in which case its contact surface with the element 33 can be a plane which in the drawing is illustrated by the dotted line 37. Part of the electromagnetic field, illustrated by the power lines 34, emitted from the signal cable 30 towards the ground cable 31, proceeds for a short length inside the support element 35. The part of the electromagnetic field that is left inside the support element is smaller than the part left in the bottom substrate in the prior art arrangement illustrated in figure 1b. In the illustrated preferred embodiment, the attenuation per unit of length is thus lower than the attenuation of an inverted microstrip cable according to the prior art.

In the embodiment illustrated in figure 4, the signal cable 40 of an inverted microstrip cable is attached to a support element 45 that is wider towards the bottom of the groove made in the element 43. The illustrated structure is composed of at least two separate elements 42 and 43. The elements are treated so that inside

them, there is created a cable cavity according to the illustration. The contact surface of the elements 42 and 43, illustrated by the dotted line 46, is chosen to be the best possible with respect to the manufacturing of the product. The contact surface of the elements 42 and 43 can be, as is illustrated, a plane of the signal cable 40 attached to the support element 45, but it may also be another plane that is advantageous for the manufacturing process. In this embodiment, part of the electromagnetic field, illustrated by the power lines 44, emitted from the signal cable 40 towards the ground cable 41, proceeds through the support element 45. However, the part that passes through the support element is remarkably smaller than in the case of the prior art inverted microstrip cable illustrated in figure 1b. Thus the attenuation per unit of length also in this embodiment is lower than in a prior art inverted microstrip cable.

In the embodiment illustrated in figure 5, the signal cable 50 of an inverted microstrip cable is attached to a support element 55 having the shape of a T-beam. The walls encasing the transmission cable are composed of at least two elements 52 and 53, and the sectional plane perpendicular to the patterns of said elements, said sectional plane being illustrated by the dotted line 56, is chosen so that the number of work steps in the manufacturing process is minimised. The support element 55 can be manufactured in several alternative ways. One alternative is to produce the support element 55 and the signal cable 50 separately, starting from the plane at the base of the T-beam, which plane is illustrated by the dotted line 57. The support element 55 and the signal cable 50 are connected, as a uniform structure, to the element 52. The ground cable 51 can be produced for instance in the way illustrated in connection with figure 1b. When the elements 52, 53 and 55 are connected together, the ground cable 51 is located in the cable cavity on the opposite side of the signal cable 50. In figure 5 it is seen that the electromagnetic field emitted from the signal cable 50 towards the ground cable 51, which field in the drawing is illustrated by the power lines 54, passes only a short way in the dielectric material, in the support element 55. As a consequence, the inverted microstrip cable according to the drawing has an extremely low attenuation per length unit, in comparison with the attenuation of a prior art inverted microstrip cable.

In the embodiment illustrated in figure 6, the transmission cable structure is composed of at least two elements 62 and 63. The contact surface of the elements 62 and 63, illustrated by the dotted line 66, is chosen to be the best possible with respect to the manufacturing of the product. It may be located at the illustrated

point, in which case it is level with the surface of the support element 65, which in the drawing is illustrated by the dotted line 66. In this embodiment, the shape of the support element is inwardly curved. The support element 65 constitutes part of the element 63. Also in this embodiment only a small part of the electric field emitted from the signal cable 60, which in figure 6 is illustrated by the power lines 64, proceeds in the dielectric material of the support element. Likewise, also in this embodiment the attenuation of an inverted microstrip cable according to the invention is low in comparison with a corresponding prior art transmission cable.

In the embodiments described above, the inverted microstrip cable according to the invention is placed in a cable cavity made of dielectric material layers. The number of the layers constituting the cable cavity wall may vary according to the employed technique and to an optimal number of working steps. The wall strength of the created cable cavity is assumed to be so good in all directions, that the other ground potential levels possibly located in the surroundings are placed far enough in order to prevent the shape of the electromagnetic field of the transmission cable from being disturbed thereby.

The invention is not restricted to the described embodiments only. For example, the structure of the walls forming the cable cavity can be divided into various levels by innumerable different ways. The employed manufacturing technique determines which method of dividing the wall parts to be created is optimal with respect to expenses and output. Likewise, the shape of the support element according to the invention can deviate from the preferred embodiments illustrated above. Also the manufacturing method of the employed signal and ground cables may be other than the suggested silk screen method. Other known cable structures, for example coplanar cable, can also be employed as the cable used in the structure. The inventive idea can be applied in various different ways within the scope of the patent claims.

Claims

1. A transmission cable constructed by multilayer technique, located in a cavity comprising a first surface and a second surface essentially parallel with the first surface, said transmission cable consisting of a signal cable (20, 30, 40, 50, 60), which is essentially parallel to the first cavity surface, and of a ground cable (21, 31, 41, 51, 61), which is placed on said second surface, essentially in parallel with the signal cable, **characterised** in that said cable also comprises a support element (25, 35, 45, 55, 65) which has a surface that is essentially parallel with said first and second surfaces and is located between said first and second surfaces, so that the signal cable is realised by means of an electroconductive material layer formed on the surface of the support element.

2. A transmission cable according to claim 1, **characterised** in that said support element (25, 35, 45) is rectangular in shape.

3. A transmission cable according to claim 1, **characterised** in that the support element is a square (25).

4. A transmission cable according to claim 1, **characterised** in that shape of the support element is a T-beam (55).

5. A transmission cable according to claim 1, **characterised** in that the shape of the support element is a surface (65) formed by two curved surfaces.

6. A transmission cable according to claim 1, **characterised** in that the signal cable is an inverted microstrip cable.

7. A transmission cable according to claim 1, **characterised** in that the signal cable is a coplanar cable.

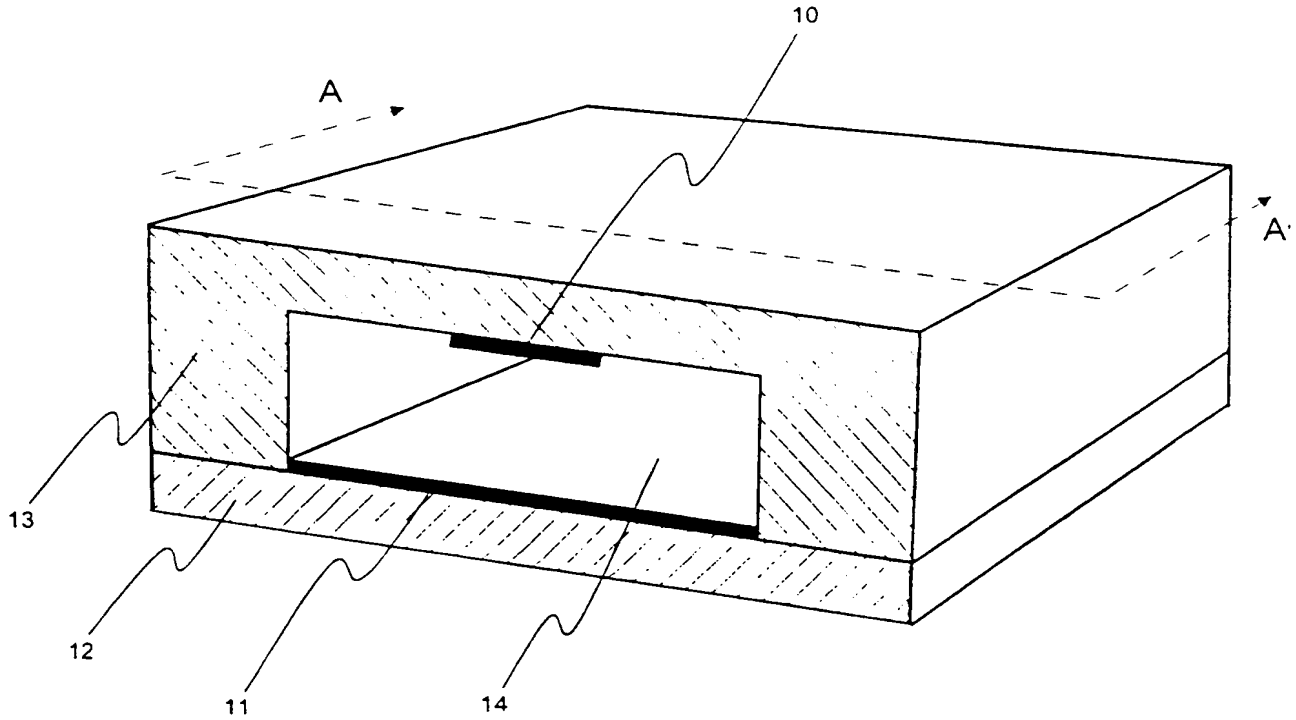

Fig. 1a

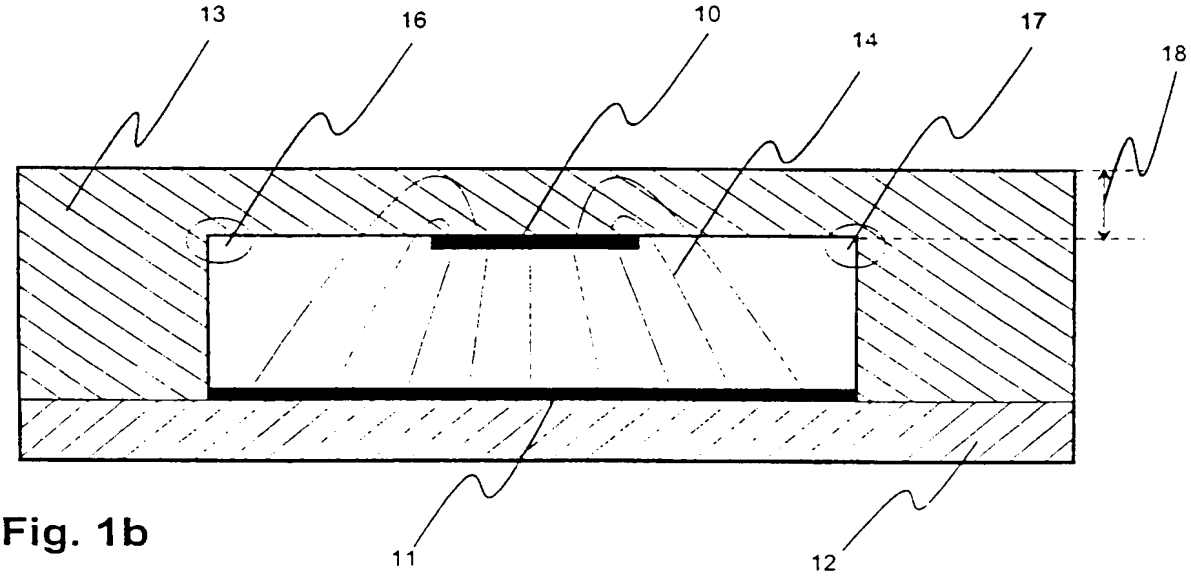

Fig. 1b

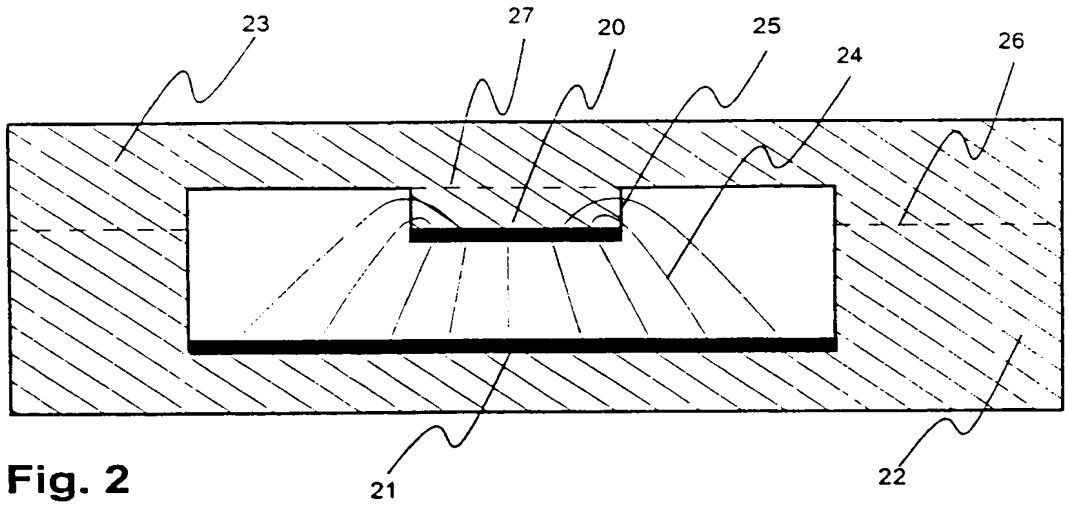

Fig. 2

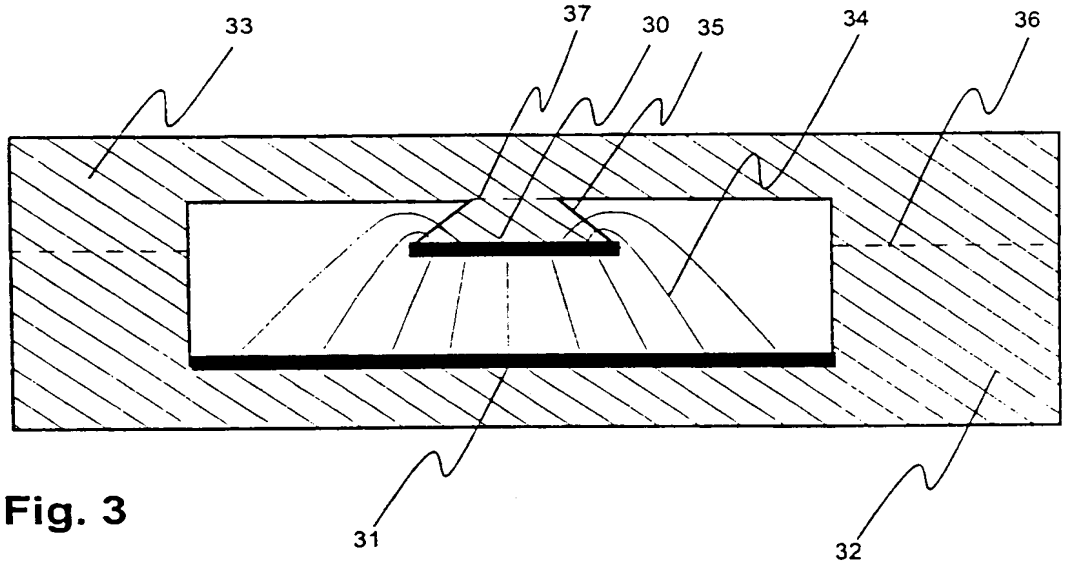

Fig. 3

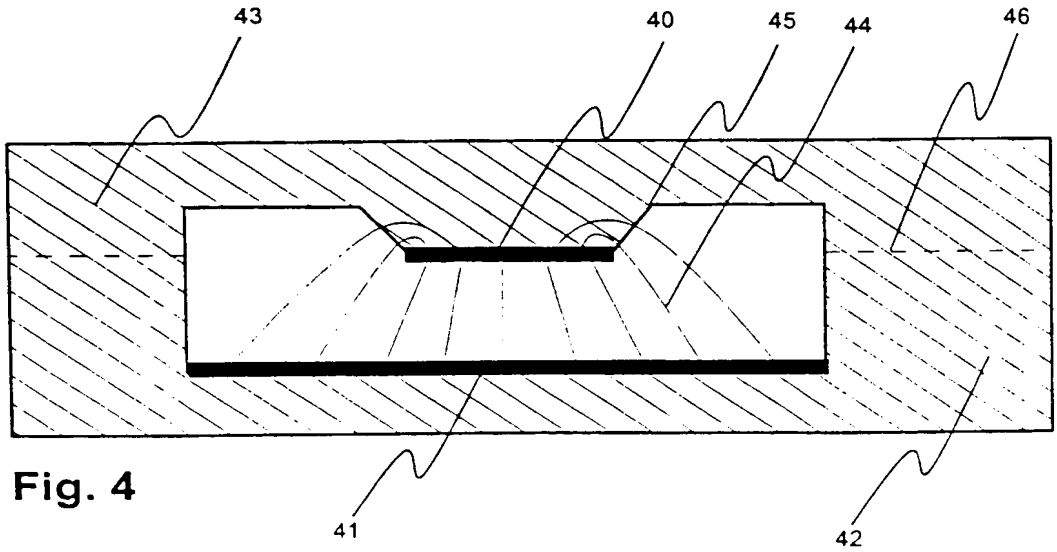

Fig. 4

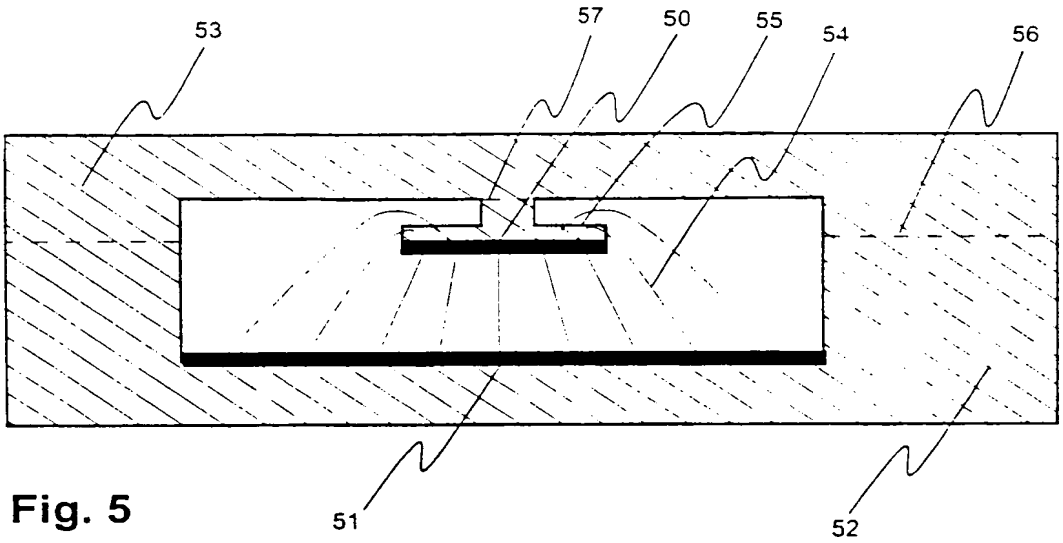

Fig. 5

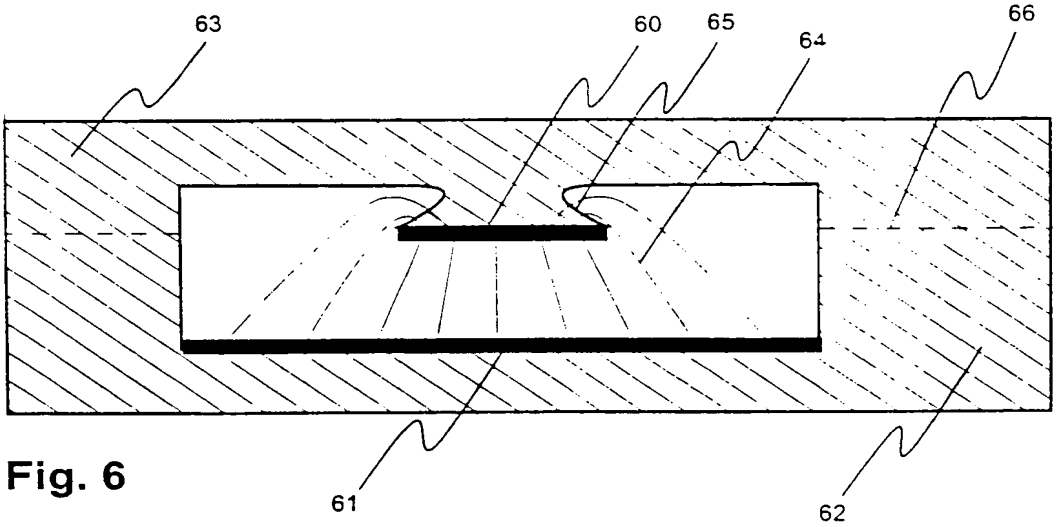

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00274

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01P 3/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0845831 A2 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 3 June 1998 (03.06.98), figures 1A, 1B, abstract --	1-7
A	WO 9302485 A1 (FUJITSU LIMITED), 4 February 1993 (04.02.93), abstract --	1-7
A	JP 4368005 A (SANYO ELECTRIC CO LTD ET AL.), 21 December 1992 (21.12.92), figures 1,4, abstract --	1-7

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
24 August 2000	28 -08- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Nikolaj Hautaviita/AE Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00274

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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D,A	US 3904997 A (H.E. STINEHELFER, SR.), 9 Sept 1975 (09.09.75), abstract --	1-7
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Information on patent family members

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US 5105055 A	14/04/92	NONE	